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State of Knowledge on Climate Change and Adaptation Activities in Thailand

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Abstract

A review of climate change and adaptation activities in Thailand has been reviewed. The country has initiated a number of domestic activities/actions to respond to climate change and climate variability in their respective country. Different levels of climate change activities are based on local activities, researchers, national and international levels. It is very challenging to assess, evaluate and synthesize relevant climate change information. The key questions are implementation to various activities and preparation to the worse case scenario.

Keywords: Climate change; Adaptation; Climate variability.

1. Introduction

Adaptation is a human intervention to address the effects of climate change, and does not include the autonomous response of the ecosystems themselves [1]. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects. It includes adjustments to moderate harm from, or to benefit from, current climate variability as well as anticipated climate change. Adaptation can be a specific action, such as a farmer switching from one crop variety to another that is better suited to anticipated conditions. It can be a systemic change such as diversifying rural livelihoods as a hedge against risks from variability and extremes. It can be an institutional reform such as revising ownership and user rights for land and water to create incentives for better resource management. Adaptation is also a process. The process of adaptation includes learning about risks, evaluating response options, creating the conditions that enable adaptation, mobilizing resources, implementing adaptations, and revising choices with new learning [24]. We mean all these things by adaptation. But the conception of adaptation as a process is often the most important for formulating public interventions that will have lasting benefits [2]. This paper is reviewed

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after Bhaktikul et al. (2009) [3]. Multiples causes and effects from climate change and human activities, such as illegal commercial logging, slash and burn agriculture, deforestation for agricultural area leading to the sedimentation and flood occurrence in many sub-basins in Thailand. These situations have been reported in the national level [4-6].

2. Historical Reviewed of GHG Emission

The National Environmental Performance Assessment Report (EPA report) is the country's first attempt to generate a clear picture of how much it has achieved in the way of safeguarding its natural resources in the past decades [7]. It has been reported that global warming phenomenon is strongly linked to anthropogenic activities in Thailand. The pressure on this matter was stated on the Indicator: Emission of Greenhouse Gases. In 1990, the contribution of three main greenhouse gas emissions (CO_2, CH_4, and N_2O) was equivalent to 225,297 Gg of CO_2. Emissions of CO_2 were the largest contributor followed by CH4 and N_2O. The energy sector was the greatest contributor to GHG emissions, accounting for approximately 35% of the total emissions, followed by land use changes (35%), agriculture (24%), industrial processes (4%) and waste (1%). It is observed that the proportion of CO_2 and N_2O emissions significantly increased from 1990. Energy sector remained the main contributor of GHG emissions but the second largest contributor has changed from land use change and forestry (e.g., forest conversion, slash-and-burn, fuel wood use) to agricultural sector (e.g., rice, livestock and agricultural soils). The energy sector accounted highest of the total emissions followed by agriculture and land use changes in CO_2-equivalent emissions. All emissions except for those of N_2O are projected to increase. The growth rate of N_2O emissions is expected to diminish during 2010-2020 in comparison to 2000-2010 under an anticipated shift in the government's policy toward greater use of chemicals (rather than biological) fertilizers. However, this policy is in conflict with protection of land degradation and hazardous waste management. Annual GHG emissions were inventoried in five main sectors, i.e., energy, industrial processes, agriculture, land use change and forestry, and wastes, and consequently converted into CO_2 equivalents by using global warming potential (GWP) scale. For example, to reduce CH_4 emissions from paddy fields, the following approaches are suggested: (i) using enhanced rice production technologies (such as minimizing the use of green manure and substituting pre-fermented compost from farm residues, adding nitrate or sulfate-containing nitrogen fertilizer to suppress CH_4 production, and several others; (ii) changing rice cultivation practices. The latter involves a progressive move away from tall (traditional) rice varieties that with high CH_4 emissions toward high yielding rice varieties with more productive tillers and shorter cropping period. This means that to change the cultivation practice, rice varieties, and farming techniques, water resources management is also changed.

3. Variability in Surface Air Temperatures

The spatio-temporal variations of monthly averaged maximum, mean and minimum surface air temperatures (Tmax, Tmean, Tmin) in Thailand during 1951 and 2003 using Principal Component Analysis (PCA) has been examined [8]. The data used from 32 meteorological stations are used. There are significant indications that ENSO events are an important source of interannual/interdecadal variability in Thailand surface air temperatures. On an interannual timescale, surface air temperatures in Thailand were anomalously higher (lower) than normal during the El Niño (La Niña) years. In addition, the overall warming trends of Tmax, and Tmin in the 1980s and 1990s were consistent with the tendency for more frequent El Niño events and fewer La Niña events since the late 1970s. This study could aid in a better understanding of some key aspects of short-and-long-term climate changes in Thailand. The results of this study can contribute to better preparation for future climate research and prediction by providing data for model construction and validation.

4. Wildfires on Biodiversity and Climate Extreme

Many severe drought years had occurred in the past. In 2007, country faced drought periods with wildfire which was taken from NASA satellite. This image is from the Moderate Resolution Imaging Spectroradiometer MODIS on NASA's Aqua satellite showed fire activity on March 19, 2007, across eastern India, Myanmar, Thailand, Laos, and China which is in Mekong basin area. As fire serves an important function in maintaining the health of certain ecosystems, but as a result of changes in climate and in human use (and misuse) of fire, fires are now a threat to many forests and their biodiversity, such as, impact to ecosystem, impacts of human induced and or severe natural wildlife on plant diversity, impact of fire on forest fauna. Of these, impacts are also included natural fire regimes, fire adapted plant species, fire adapted fauna, loss of habitat, territories, and shelter, which will consequently effect to loss of food security within the basin. In addition, research carried out by the National Aeronautics and Space Administration (NASA) has recently proven that smoke from biomass burning inhibits rainfall. Measurements from NASA's Tropical Rainfall Measuring Mission (TRMM) indicate that in clouds polluted with smoke from forest fires the warm rain processes in the clouds are practically shut off [9].

5. Trend of Temperature, Rainfall and Flood Events

The increased temperature records are dramatically explicit to explain how much climate change condition is going on in this country. Both droughts and floods events are more frequently spread of over the past 20 years. From the annual rainfall record during 1951-2005, trend of average annual rainfall in Thailand is declined [10]. Flood events is average 11 events a year in Thailand; number of deaths 150 per year in average but more than 400 deaths in 2011. Agricultural area loss 1.5 million hectare per year. The number of deaths by flash floods each year underscores the ongoing difficulty of providing adequate warning. The need for flood risk mapping and land use zoning strategies such as residential area must not located on risk area is strongly recommend [11]. Losses from flash floods including related hazards such as landslides and debris flows, appear to increase due to pressure on land resources. The adaptation activities such as risk identification using flood risk mapping; vulnerability identification and building designs to live with floods, and the implementation of mechanisms that ensure effective warnings and emergency response at the local scale are suggested immediately response. While, wind speed, and waves high by NE and SW monsoon during 1987-2007 shown more frequency severe [12].

6. Potential Climate Change with CO_2 Scenarios

Snidvongs et al. [13] worked out how the climate in Mekong River Basin region may change when the carbon dioxide (CO_2) has reached double level from the present level, and what may happen in the region if the water resources change as the result of climate change in the future. The results of future climate change in the region as reported in this paper are outputs from the regional climate modeling technique, not from the global model downscaling technique usually used in other studies. The outcomes of different climate and hydrological models shown are only to demonstrate on how these quantitative outputs may be used to assess future impacts and vulnerability of human society to climate change. These outputs was recommended not to be taken as the 'predicted' climate and hydrological regimes, but they are just 'scenarios' that may or may not happen in the future as there are many other factors that needed to be taken into consideration beside just only atmospheric CO_2 level. Consequently, during 2003 to 2006, SEA START RC initialised climate change scenarios using Conformal Cubic Atmospheric Model at the Southeast Asia regional level [14]. The impact of climate change on hydrological condition and rain-fed agriculture in Southeast Asia is focused on the lower Mekong River basin as well as assessed vulnerability and adaptation of rain-fed farmer to climate change impact. Future climate scenarios were developed using climate model with given condition of increasing atmospheric CO_2 concentration from

the baseline of 360 ppm to 540 ppm and 720 ppm, Some selected daily outputs were maximum temperature, minimum temperature and average temperature, rainfall (mm/d), wind speed (m/s) and direction, radiation (W/m^2), specific humidity (kg/kg), heat flux (W/m^2), pressure (hPa), and cloud cover (%). The result from the simulation suggested that average temperature in the region tends to be slightly colder under climate condition at CO_2 concentration of 540 ppm but will be slightly warmer than baseline condition under climate condition at CO_2 concentration of 720 ppm. The range of temperature change is 1-2ºC.

With some limitation of this down scaling model, the result showed that the hot period of the year will extend longer and the cold period will be significantly shorter while the length of rainy season would remain the same, but with higher rainfall intensity. These changes in climate pattern will result in higher discharge of most of the Mekong River tributaries, which is higher proportion to the increasing in precipitation. Agriculture sector, especially rain-fed system will also be affected from change in climate pattern. The result from simulation using crop modeling technique shows that yield of rice productivity in the study site in Thailand will increase by 3-6%; but on the contrary, may reduce by almost 10% in the study site in Lao PDR. The rice production in the Mekong River delta in Viet Nam tends to have severe impact from climate change, especially summer-autumn crop production, of which the yield may reduce by over 40%. Change in rice productivity was used as proxy of climate change impact to assess risk and vulnerability of rain-fed farmer. The assessment shows that vulnerability to climate change impact of the farmers in the lower Mekong River region vary from place to place, according to degree of climate impact as well as socio-economical and physical condition in each location. Result from farmer survey in selected communities in Lao PDR, Thailand and Vietnam shows adaptation strategy that is shaped by the socio-economic condition of their surrounding community. Farmers in communities with less developed socio-economic conditions, such as Lao PDR, tend to pursue simple strategies targeted at increasing cropping capacity and sustaining basic needs that can be implemented at the household or community level with limited financial and other resources. Farmers in communities with more developed socio-economic conditions, as the case study in Thailand, tend to pursue strategies targeted at reducing the variability of income and at improving the productivity and resilience of their farms. The measures that they adopt tend to depend more on market and other institutions, improved technologies and financial resources than the case for farmers in less developed communities.

Another application of CCAM model is at Songkram river basin. This is an outcome of the collaboration between IRG, IUCN and SEA START RC under USAID initiative [15]. The objective is to conduct pilot assessment on impact, vulnerability and adaptation of the people of Songkram River basin to the climate change. The study was intended to be a demonstration on the methodology in the assessment process on climate change vulnerability and adaptation. The result showed that maximum and minimum temperature in the Songkram river basin will only slightly change. The annual hot period in the river basin will be substantially longer, and on the contrary, the cool period will be shorter. The precipitation will be slightly increased throughout the river basin. Results provided to Thai Government for consideration in the development of the National Strategic Plan on Climate Change that will include adaptation strategies in five vulnerable sectors and an adaptation capacity building strategy [16]. Adaptation options identified for the pilot study at Songkram river are infrastructure, capacity building, policy on compensation and develop resource management plans at the community level, and new practices i.e. shift to flood-tolerant crops.

In 2008, CCAM model was replaced with PRICIS Model. SEA START RC launches another research topic on climate change and sustainable development in regional scale on Mekong River Basin. In this 11-month basin-wide climate change research, sub-component, future climate scenarios over 21st century is being developed for the Mekong River Basin at high resolution of .22 degree (approximately 25 km x 25 km). PRECIS regional climate model is used and developed as simulation tool by The Met Office Hadley Centre for Climate Prediction and Research. Different scenarios under two different CO_2 rising schemes, SRES A2 and B2, are generating to give range of future climate change. These climate

scenarios are being used as foundation for climate change impact analysis in the basin. Basin-wide hydrological analysis will be done using distributed hydrological model that uses the climate scenarios as boundary condition for precipitation and temperature. The impact of climate change on bio-physical systems with focus on hydrological regime and ecosystem services will be analysed using EIA 3D hydrodynamic modelling tools, developed during the WUP-FIN Project. However, selected area in this research is Tonle Sap in Cambodia, and Mekong Delta in Vietnam. Later, some climate condition forecasting using PRECIS model [17] has developed by The Met Office Hadley Center for Climate Change, UK with global dataset ECHAM4 as baseline data. resolution 25 km such as trend of number of days that temperature above 33 Celsius, and number of days that temperature below 15 Celsius.

Bhaktikul [18] and Noimunwai, et al. [19] pursued the continuing study on the potential evapotranspiration for forecasting crop evapotranspiration using the scenarios, base line CO_2, 1.5 and 2 times of CO_2 at baseline data. Data Mining Technique was used for forecasting potential evapotranspiration (ETo). Crop evapotranspiration, such as rice, maize, etc. are generated following the ETo values in the study area of Lam Pra Plerng Basin. Climate data from the Thai Meteorological Department during 1980 to 1989 is used to create the model. The Artificial Neural Networks model (ANNs) is performed with input 118,742 climatic input data. The variables such as months, maimum temperature, precipitation, maximum wind speed, solar radiation, relative humidity, and evapotranspiration are included into model run. It is found that the increasing concentration of CO2 affects ETo. When CO_2 concentration increases from 360 to 540 ppm it will decrease ETo 17% in January, May, September, and December, while for the rest of the year ETo will decrease 7%. If CO2 concentration in double to 720 ppm it will affects ETo by increasing up to 10% in January, March, May, and June, meanwhile in July, August, September, October, and December ETo will decrease 4%. The result show the successful of the forecasting that closing to actual evapotranspiration with data mining techniques in comparison with potential evapotranspiration with Penman method and country ETo data also present in GIS. The researcher has been invited to present in the international training of UNDP [20]. Result of this study can be used to further study on various adaptation such as; shifting of crop calendar, adjustment of reservoir operation study and operational rule curve, preparation of irrigation water requirement in the area, water management, preparation for real time water allocation in the time of flood and drought etc. In the early of this, Bhaktikul et. al. [21] found out the correlation on climate data to the dengue fever case in Thailand.

7. Activities Related to Non-government

In December 2005, Butthep et al. [22] together with representatives from NRCT, LDD, RFD, the Department of Forestry at Michigan State University, and some others participated an initial meeting at ONEP. The discussion was on possible opportunities for terrestrial, biotic carbon sequestration projects in the context of UNFCCC-CDM, voluntary carbon markets and sustainable development. This meeting had formalized an active group of participants and established a target pilot area under the project named "Advanced Technologies for measuring, monitoring and managing carbon sequestration in community-based agro-forestry and linking CO_2 offsets to carbon financial markets for sustainable land use and development" (Butthep, et al. 2008). Project's activities were to develop field test, and refine advanced protocols for Kudbak District, Sakon Nakhon Province, Thailand. The project aims to link carbon sequestration from community-based agro-forestry, implemented by members of the Inpaeng Community Network, to the Chicago Climate Exchange, a carbon financial market, or to an analytical technologies for carbon accounting and project management implemented with Internet services. Techniques used in this project are remote sensing satellite data, GIS, GPS, numerical carbon models, and web-enabled geo-spatial and database applications. Project work for 2008 has emphasized on three primary activities: (1) Establishment of permanent plots and biometric data collection in Inpang member small-holder, teak areas (2) Calculation of carbon stocks and ex ante calculation of carbon sequestration in Inpang member

small-holder, teak areas (3) Development of the web-based project carbon registry. Information specific to the three primary activities at Inpang Teak Project are 49 teak farms, with total area of 82.764 ha, 85 sample plots, and 6238 number of trees sampled. There are 4,000 households join in this voluntary project. The teak forest in this area has been already afforested for about 15 years under the governmental support. Villagers who volunteer in this project must continuously maintain these forest areas for further 30 years.

In December 2008, the Project Report Update was published, and entitled "Carbon Offset Project Inpang Community Network Northeast Thailand", prepared by Butthep, et al. [23]. At the end of this year (2008) carbon credit will be started selling to CCX market (Chicago Climate Exchange Market) in USA through Michigan University. Even though the idea is indirectly related to water resources management, but this activity is actually help for sustainable of ecosystem and community itself at the end. However, latest news in November 2009 on the negotiation between Inpang Community network and Michigan University is declined because the cost effectiveness of project is too low.

Global Learning and Observations to Benefit the Environment (GLOBE) is an international education programme of National Oceanic and Atmospheric Administration – National Aeronautics and Space Administration – National Science Foundation – Department of Education and State, USA, in which coordinating contact in Thailand is Institute of Promotion of Science and Technology Teaching. The GLOBE educates students aging 8-15 years focusing on earth system environment. The GLOBE launches a campaign on climate change called "The Student Research Campaign on Climate Change 2009-2013" It is said to provide a framework for meaningful, relevant and important research on set of interrelated environmental topics to enhance climate literacy and understanding millions of students and their communities. This program will enlist the support of internationally renowned climate change scientists, science educators and educational outreach experts, as well as business, foundations and policy makers. Student research activities commence in 2011. The final results of the campaign to be presented at an international conference in 2013.

Medias such as televisions and broadcasting in mass communication, mass media, spot radio, magazine, newspaper, and social media are playing their roles in the awareness raising on climate change. Most of the purposes are for "Action Now" strategies to urge the consumers on helping mitigate and adapt to climate change, and also to diminishing the gap of feeling that climate change is far away from our daily life to be "Climate change is with us in daily life". Most of these are in general overall country. Among these, an example of True who initiates campaign to stop climate change, as True Vision Award 2008, Available: www.Truelife.com, Private Sector Climate Change Awareness Raising Schemes.

8. Conclusions

From the review of past, on-going and future work of the country on climate change and adaptation, research institutions are playing an important part in regional and national work which have been innovative and provided important reflections on the national scale situation. The outcomes of regional modelling and predictions are available on potential impacts on climate change. Thailand is still lacks of baseline information for understanding the complex interplay between and within natural and human systems and a considerable gap in information on likely changes in climate and human systems in different ecosystems and agro-climatic systems. National scale assessment based on models failed to incorporate human dimensions, particularly livelihood aspects and inter-sectoral relationships. Without such national assessments as a sound basis for designing and planning adaptation policies, strategies and programmes, decisions on adaptation will remain uncertain and will not lead to effective results from implementation. Baseline data between different organisations working on climate change must be shared. Researches in modeling are required in linking to community adaptation. Transferring basic knowledge on climate change adaptation is required.

Multiples causes and effects from climate change and human activities, such as illegal commercial logging, slash and burn agriculture, deforestation for agricultural area leading to the sedimentation and flood occurrence in many sub-basins in Thailand. These situations have been reported in the national level [4-6].

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